



Original Communication

Sexual dimorphism of the index to ring finger ratio in South Indian adolescents[☆]

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ABSTRACT

Sex determination from prepubertal human remains is a challenge for forensic experts and physical anthropologists worldwide as definitive sexual traits are not manifested until after the full development of secondary sexual characters that appear during puberty. The research was undertaken in 350 South Indian adolescents to investigate sexual dimorphism of the index and ring finger ratio. The index finger length (IFL) and the ring finger length (RFL) were measured in millimeters in each hand and the index and ring finger ratio was computed by dividing the index finger length by the ring finger length. Mean RFL was greater than mean IFL in both males and females. Mean RFL was significantly higher in males. The index and ring finger ratio showed a statistically significant difference between males and females ($p \leq 0.001$). The index and ring finger ratio was found to be higher in females (0.99) when compared to their male counterparts (0.95). The index and ring finger ratio thus shows sexual dimorphism in the South Indian adolescents that may prove useful to determine the sex of an isolated hand when it is subjected for medicolegal examination. The study suggests that a ratio of 0.97 and less is suggestive of male sex, while a ratio of more than 0.97 is suggestive that the hand is of female origin among South Indian adolescents.

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1. Introduction

Identification of human remains is an imperative element of any medicolegal investigation and determination of race, sex, age, and stature remain the foremost criteria in establishing the same. Accurate sexing of the remains is vital as it primarily narrows down the pool of possible victim matches. Besides, it is also important owing to the difference in age of epiphyseal fusion, and different formulae for stature estimation in males and females. It is not uncommon to find the peripheral parts of the body such as hands and feet in mass disasters, and assault cases where the body is dismembered to conceal the identity of the victim. Somatometry of the hand, osteological and radiological examination can help in the

determination of primary indicators of identification such as sex, age and stature.^{1–17} Earlier studies on sex determination from morphometric parameters of the hand have focused mainly on the adult populations.^{16,17}

Definitive sexual traits are not manifested until after the full development of secondary sexual characters that appear during puberty. Paucity of literature on the issue of determination of sex from dismembered remains among adolescent populations has prompted the authors to take up this work. The present research was undertaken to investigate sexual dimorphism of the index and ring finger ratio in South Indian adolescents.

2. Material and methods

The present study was conducted on 350 adolescents (175 males and 175 females) of South Indian origin aged between 13 and 18 years in two schools of Manipal after obtaining informed consent from the school authorities. The hand was placed on a flat surface with the palm facing upwards and the fingers extended and

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close to each other. The index finger length (IFL) and the ring finger length (RFL) were measured in each hand using a steel measuring tape. The distance between the mid point of the proximal most flexion crease at the base, and the most forward placed point (tip) of the index and the ring fingers along the midline on the ventral (palmer) surface were recorded for each hand to the nearest millimeter.¹⁷ Care was taken to see that there was no abduction or adduction at the wrist joint. The index and ring finger ratio was computed by dividing the index finger length by the ring finger length.

The subjects with any disease, deformity, injury, fracture, amputation or history of any surgical procedures of the index or ring fingers of either hand were excluded from the study. The data obtained were analyzed statistically using SPSS (Statistical Package for Social Sciences, version 11.0) computer software. Student's *t*-test was performed to compare the index and the ring finger lengths and the ratio in the two hands, and between both sexes. Statistical significance was defined at the standard 0.05 level. The sectioning point was derived for sex differentiation from the index and ring finger ratio.

$$\text{Sectioning Point} = \frac{\text{Mean male value} + \text{Mean female value}}{2}$$

3. Results

Descriptive statistics for the index and ring finger lengths for both the hands in males and females are shown in Tables 1 and 2. In our study, the ring fingers were significantly longer among males than females in both the hands. The index finger length did not show any statistically significant difference between males and females. The difference between the mean RFL and the IFL was 3.4 mm in the right hand and 3.3 mm for the left hand in males, and 0.8 mm for the right and the left hand in females. The difference between the mean RFL and IFL between males and females is highly significant ($p \leq 0.001$) in both the hands. No significant differences were observed in the finger lengths between the right and left hands.

The index and ring finger ratio derived from the finger lengths ranged from 0.88 to 1.00 in males with a mean of 0.95, and from 0.92 to 1.06 with a mean of 0.99 in females for the right hand. For the left hand, the index and ring finger ratio ranged from 0.89 to 1.00 in males with a mean of 0.95, and from 0.90 to 1.05 with a mean of 0.99 in females (Table 3). The derived ratio showed a statistically significant difference between males and females ($p \leq 0.001$). No significant differences were observed in the index and ring finger ratio between the two hands.

A 'sectioning point' was derived for the index and ring finger ratio to discriminate male and female hands as 0.97. The index and ring finger ratio accurately determines sex in 83% males and 74% females for the right hand, and in 82% males and 80% females for the left hand, when all the cases with ratios below and equal to 0.97 were considered males and those above 0.97 were considered

Table 2

Descriptive Statistics: Index and Ring Finger Length (mm) in Females.

	Right Hand		Left Hand	
	IFL	RFL	IFL	RFL
Minimum	52	53	52	53
Maximum	77	78	77	78
Mean	65.2	66.0	65.2	66.0
S.D.	4.3	4.3	4.3	4.3

S.D. – Standard Deviation, IFL – Index Finger Length, RFL – Ring Finger Length.

females in the study group. Distribution of the index and ring finger ratio among male and female adolescents in both the hands is depicted in Fig. 1.

4. Discussion

Sexual dimorphism in the extent and length of the fingers has been documented from interdigital ratios, i.e. the various possible ratios for different finger lengths. The sex difference in these ratios is independent of the body size, as the ratios are not significantly related to the height and age in either sex.¹⁸ In females, the index and ring fingers tend to be almost equal in length, whereas in males the ring finger tends to be much longer than the index finger. Thus, the index and ring finger ratio becomes a significant parameter for determining sex.¹⁷ Voracek based on a comparative analysis of earlier studies concluded that the index and ring finger length ratio is only modestly sexually differentiated, and thus an inappropriate trait for sex determination. He however, adds that the ratio as a weak marker for sexing, to some extent might still prove useful in otherwise unsexable cases (i.e., when DNA analysis cannot be performed).¹⁹

In the present research, the ring fingers are significantly longer among adolescent males than females. Morphological sex differences in the absolute length of fingers have been demonstrated in various studies, male fingers being longer when compared to females.¹⁵ Sex difference in the length of the ring finger is found to be larger as compared to the length of the index finger, similar to a study by Lippa.¹⁸ In our study, the mean index and ring finger ratio in males is significantly lower than females in both the hands. Our findings are comparable to observations in other studies where on average males demonstrated lower digit ratios than females.^{17–22} The extent of sex differences however, varies in different studies and population groups.

Lower digit ratios have been considered "masculine" and higher ratios as "feminine". Manning reports that the length of the index finger is generally about 96 percent of the length of the ring finger, thus the average index and ring finger ratio for males is 0.96.²³ A much detailed scientometric analysis and bibliography of research on digit ratio is published by Voracek and Loibl.²⁴ Findings of our study with regard to sexual dimorphism of the index and ring finger ratio in South Indian adolescents are similar to those observed in the South Indian adult population,¹⁷ suggestive of the

Table 1

Descriptive Statistics: Index and Ring Finger Length (mm) in Males.

	Right Hand		Left Hand	
	IFL	RFL	IFL	RFL
Minimum	53	56	53	56
Maximum	79	83	79	83
Mean	64.9	68.3	64.9	68.2
S.D.	5.5	5.8	5.6	5.9

S.D. – Standard Deviation, IFL – Index Finger Length, RFL – Ring Finger Length.

Table 3

Descriptive Statistics: Index and Ring Finger Ratio in Males and Females.

	Right Hand		Left Hand	
	Male	Female	Male	Female
Minimum	0.88	0.92	0.89	0.90
Maximum	1.00	1.06	1.00	1.05
Mean	0.95*	0.99*	0.95*	0.99*
S.D.	0.02	0.03	0.03	0.02

S.D. – Standard Deviation, *p value 0.001.

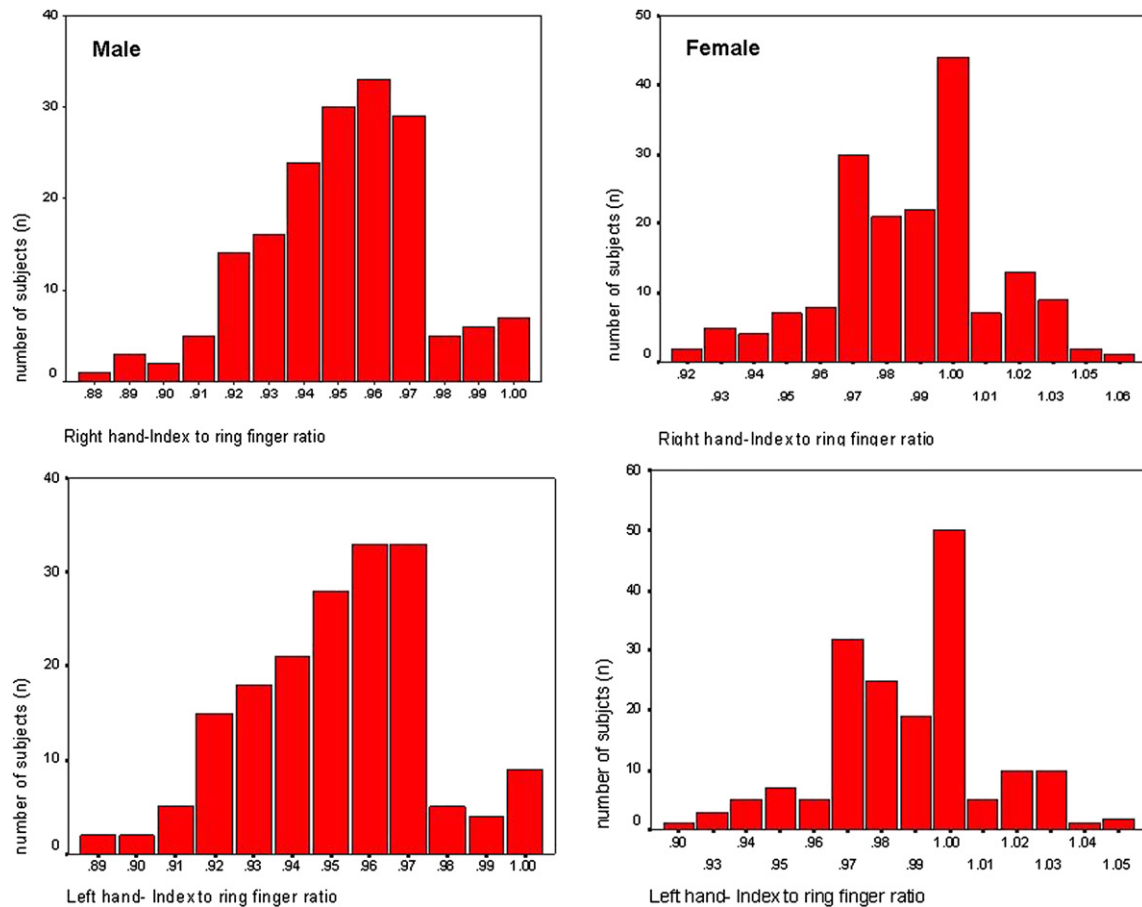


Fig. 1. Distribution of index and ring finger ratio among male and female adolescents.

fact that the index to ring finger ratio does not change with age and growth in a population group, similar to the observations of Manning.²³

5. Conclusions

The decedent's sex may not be obvious in dismembered human remains. For these scenarios, techniques for sex determination may play a vital part of the medicolegal investigation. With the advent of DNA technology, the issue of sex determination appears to have simplified, but technology has limitations with regards to skilled persons, time constraints and financial issues involved, especially in developing countries.

The present study reveals that the index and ring finger ratio shows sexual dimorphism in the South Indian adolescent population. The index and ring finger ratio is found to be higher in females when compared to their male counterparts in both the hands. The study suggests that a ratio of 0.97 and less is suggestive of male sex for both the hands, while a ratio of more than 0.97 is suggestive that the hand is of female origin.

The study may prove to be a cost effective, easy to carry out, relatively less time consuming and a reasonably reliable alternative to determine the sex of an isolated hand. It can be especially useful in mass disasters and also when only a distal part of the hand with index and ring fingers is subjected for examination. Similar studies are proposed to confirm the findings of our study and to find the degree of sexual dimorphism in the index to ring finger ratio in other populations.

Conflict of interest

The authors have no conflict of interest to declare.

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Ethical approval

None.

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